Preface

AN ANIMAL SCHOOL

Once upon a time, the grown-up animals of the forest decided they needed to properly educate their youngsters to successfully cope with the ever-increasing demands of living in a woodland community. Faced with the prospect of human invasion, the animal elders met at the local stream. After squabbling among themselves as to what to do, they ultimately decided that they needed to start a school. Days later, a committee was formed to write the learning standards and curriculum for all the animals of the forest. The subjects consisted of running, climbing, swimming, and flying. It was expected that *all* the animals were to meet the competence level for *all* the subjects.

The duck proved to be excellent at swimming, better, in fact, than his teacher. The duck also did pretty well in flying but proved to be well below standards in running. Since he was so poor in running, his teacher made him stay after school to practice running. The duck argued that running didn't fit his needs and interests. Eventually, he even had to drop swimming (his favorite subject) to improve his running skills.

The rabbit started out at the top of her class in running but had anxiety attacks when it came time for swimming lessons. The rabbit always asked for a pass to the nurse's office just before swimming class was about to begin. The rabbit also abhorred climbing and flying classes since she was afraid of heights. She petitioned the school principal to be excused from these subjects, but her request was immediately denied.

The squirrel was excellent in climbing and above average in running but had a fear of flying. He said he had a cousin that was good at flying, but he wasn't. The squirrel also petitioned the principal, asking if leaping could be substituted for flying. The squirrel demonstrated that he could leap from tree limb to tree limb, but his petition too was denied. At the end of the semester, the squirrel received a C in climbing and an F in flying. The squirrel felt he received a lower grade in climbing because by going to the principal he had angered the teacher.

The Animal School story is adapted from an earlier version believed to be written in the 1940s by George H. Reavis, Assistant Superintendent of Schools in Cincinnati, Ohio.

The eagle was the school's star flyer. During climbing class, she would fly to the top of the tree instead of climbing; all the other animals accused her of cheating. The eagle insisted that she could get there any way she chose as long as she got to the top of the tree. Another petition to the principal's office resulted in another denial. On his report card, the eagle got an A in flying but a D in climbing.

The groundhog disliked school because digging was not part of the curriculum. He detested all the approved subjects and eventually stopped attending classes because he was failing everything. The groundhog asked the animal elders if the school could have an extracurricular class in digging. The groundhog even volunteered to teach the class. The elders refused his offer, explaining that digging wasn't part of the curriculum. Knowing that he would have little or no chance to successfully petition his cause to the principal, the groundhog just decided to drop out of school.

Although you may have already heard or read versions of this story before, take a few minutes to think about the significance of the story. If you are with colleagues, share and discuss your responses together. If you are alone, write some comments in the margin that express what you are thinking.

Consider the following questions:

- What does the story tell us about the reality of school for scores of today's elementary, middle, and high school students?
- How does the story depict many of the schools and classrooms we teach in today?
- How does the story reflect the growing needs of individual students, especially those with special learning needs?
- How do high-stakes statewide assessments drive instruction in local school districts?

The purpose of the story is to introduce the need for differentiated teaching based on students' needs and levels of interest and readiness. In most science classes across the country, it is the teacher (not the student) who decides what topic will be taught, what teaching method is appropriate for the topic, and how learners will demonstrate their understandings. Teachers and administrators have control over 99% of the school day—from when and how learning will occur, to when a student can eat lunch, sharpen a pencil, or even go to the bathroom. Unfortunately, students have very little say in school matters. These common traditions are often dictated by district expectations, economic resources, the growing number of students assigned to any particular classroom, or, most assuredly, the attitudes and beliefs of teachers that control what needs to be maintained to ensure a safe and secure classroom environment.

THE PURPOSE OF THIS BOOK

This book proposes that, contrary to this commonly accepted practice of "one-size-fits-all" instruction, teachers can frequently modify their

time-honored activities to make them more or less structured, as well as more or less inquiry oriented. Driven by students' range of learning styles, the purpose of this book is to take the reader into the "why's and how's" of differentiating science hands-on activities—especially those categorized as "inquiry-based." The book will also suggest times when it is appropriate for the teacher to choose the instructional strategy and other times when the students can have a choice in the way they learn best. This will be accomplished by introducing a rationale for Differentiated Science Inquiry (DSI) in Part I of the book and providing numerous "pathways to inquiry" with examples of lessons in life, earth, and physical science in Part II.

After reading this book, you will conclusively be able to *identify* when it is most appropriate to differentiate a science inquiry and how to *transform* many of your already favorite conventional activities and labs into a variety of approaches to inquiry.

BALANCING MEANING AND MECHANICS

Science teachers recognize the importance of the concept of balance. Balance is a universal phenomenon in understanding our natural world—whether it's studying a balanced ecosystem, balancing a chemical equation, or considering the notion of opposing forces in stability within the geological world. As humans, we understand the need for a healthy, fit balance within our own bodies as well as keeping our personal checkbook balanced for a means of judging or deciding when we can and can't afford to buy that expensive item.

As complementary forces tend to balance one another, it is the position of this author that exemplary inquiry-based science teachers should be able to articulate not only *how* they do inquiry but also *why* they do it. By balancing *meaning* (the why) and *mechanics* (the how), teachers are in a better position to convey to their colleagues, students, parents, school administrators, and community stakeholders the benefits of teaching and learning through scientific inquiry. In this case, knowing *why* something's important is just as vital as knowing *how* to do what's important. Think of it as the juxtapositional balance of theory and practice: the equilibrium of minds-on coupled with hands-on. Or imagine it as the yin and yang of inquiry.

To help enlighten this notion, after an introduction that briefly revisits the definition of scientific inquiry, this book is divided into two sections. Part I includes the "why" in Chapters 1 through 5, while Part II includes the "how" in Chapters 6 through 10. Chapter 1, "Pathways to Inquiry," classifies various approaches teachers can use to engage their students in inquiry-based learning. The approaches that can lead students into inquiry explorations include demonstrated inquiries and discrepant events, structured inquiries, guided inquiries or problem-solving situations, and self-directed or student-initiated inquiries. The advantages and appropriateness of each approach are described in detail.

Chapter 2, "The Art and Science of Inquiry," builds upon the "Invitation to Inquiry Grid" introduced in *Inquire Within* (Llewellyn, 2007). Although

structure and guidance are essential aspects of learning, frequent classroom observations tell us that science teachers too often rely on directed and procedural activities without enabling students to investigate the natural world on their own. In this chapter, an analogy will be drawn paralleling how children learn to paint to how they learn to do science.

Chapter 3 attempts to coin a new term for science educators—"Differentiated Science Inquiry." Chapter 3 dismisses the argument that "one size fits all" and provides a counterargument based on the logic and underlying principles for differentiating science inquiry.

Chapter 4, "Why Teachers Differentiate Science Instruction," introduces the reader to background on students' varied learning styles and how tiered assignments, scaffolding, and flexible groupings help meet students' individual learning needs.

Chapter 5, "Motivation: The Key to Unlock Learning," asks the question: Why are students more engaged in investigating their questions than those given to them by the teacher? The answer lies in "ownership." Developing student voice and ownership for investigative questions is a central attribute of science inquiry. This chapter describes how student ownership and choice develop character and competence. The chapter also highlights current research showing that providing choice enhances intrinsic motivation and ultimately leads to self-directed learning and increased academic achievement.

Part II comprises Chapters 6 through 10, where readers are provided with suggestions how to modify an activity or lab into a DSI approach along with examples of lessons tailored to each of the four inquiry approaches in life, earth, and physical sciences. Last, Chapter 10, "Making a Commitment to Differentiated Science Inquiry," tells the story of one high school science teacher and her journey and transformation to DSI.

WHO THIS BOOK IS WRITTEN FOR

This book is written for elementary, middle, and high school teachers who already have a fundamental background and understanding of scientific inquiry. Whereas my previous books, *Inquire Within* and *Teaching High School Science Through Inquiry,* focus on defining and describing scientific inquiry, this book takes the next step in one's professional inquiry journey by illustrating a deeper awareness of the various approaches to science inquiry and how teachers in Grades 3 through 12 can adapt and facilitate an array of inquiry methodologies geared toward meeting the diverse instructional needs of their students.

This book has multiple audiences. It is written for teachers studying about scientific inquiry in either an advanced undergraduate or graduate-level methods course. The book is likewise geared to those participating in a summer science institute or teacher-leaders and experienced science specialists that coach and mentor novice and apprentice-level teachers through their own inquiry journeys. Others might use *Differentiated Science Inquiry* as a book study within a collegial support group or a literature circle as a way to extend their work in scientific inquiry. Reading and

reflecting on the chapters, examples, and vignettes is an excellent way to develop a professional learning community of inquirers.

Last, but equally important, are those science teachers pursuing National Board Certification for Early Adolescence (ages 11–15). Developing and implementing a lesson centered on differentiated science inquiry provides a novel means to demonstrate competence for your portfolio submission for the standard "Advancing Student Learning—Science Inquiry."

Regardless of how it's used, this book is for the science educator who considers him- or herself (as I do) a "student of inquiry" and desires to advance one's proficiency for inquiry-based teaching to a new level. Toward that purpose, I hope you will find the "voice" of this book to be sounding more like a coach or a mentor than of an expert trying to impart knowledge to the reader. Now, if you're ready, let's get started.